TECHNION, ISRAEL INSTITUTE OF TECHNOLOGY
Department of Mechanical Engineering

Robot Navigation
Part #1 of Mini-Project

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C-space for a Polygonal Robot in a Polygonal Environment

This is Exercise 7(a) of Chapter 3 in Latombe's book. In Section 1.6 of Chapter 3 an algorithm is described for building fixed-θ slices of the c-space obstacle CB due to a *convex polygonal robot* $\mathcal{A}$ intersecting a *convex polygonal obstacle* $\mathcal{B}$.

1. Write a program that implements the algorithm as follows:

   - **Input:** Description of a convex polygonal robot and a single convex polygonal obstacle, as a list of their vertices described in counter-clockwise order.

   - **Output:** For 32 regularly spaced θ layers (starting at $\theta = 0$ until $\theta = 2\pi - 2\pi/32$), compute the vertices of the c-obstacle slices, and draw the lines connecting these vertices.

   - **Test:** Test your code on the robot $\mathcal{A}$ and the obstacle $\mathcal{B}_1$ given in Figure 1. Give us *a copy of your code and a printout of layers* $1, 8, 16, 32$.

2. Extend your code to accommodate a list of possibly overlapping convex polygonal obstacles. Test your code on the example of Figure 1. The example shows an apartment with two bedrooms and a living room connected by a short corridor. The outer wall is represented by a union of four rectangular obstacles $\mathcal{B}_{0_1}, \mathcal{B}_{0_2}, \mathcal{B}_{0_3}, \mathcal{B}_{0_4}$. The interior walls are rectangular obstacles $\mathcal{B}_1, \ldots, \mathcal{B}_5$. The two doors are $\mathcal{B}_6, \mathcal{B}_7$. Coordinates of $\mathcal{B}_2$: $(17, 17), (18, 17), (18, 29), (17, 29)$. Coordinates of $\mathcal{B}_{0_1}$: $(0, 29), (32, 29), (32, 30), (0, 30)$. Use the figure to build the input. Give us *a printout of layers* $1, 8, 16, 32$. It would be nice if you mark in each slice the regions belonging to the respective physical obstacles.

3. As a preparation for part #2 of the mini-project, set up an (x, y, θ) grid of dimension $32 \times 32 \times 32$. For every θ layer, fill the cells of the respective c-obstacles boundaries by 1. The others should be filled with 0. Note that you will need a code that draws a discretized straight line between two given endpoints. Note, too, that portions of the c-obstacles corresponding to the outer wall spill out of the grid. Give us *a printout of layers* $1, 8, 16, 32$.
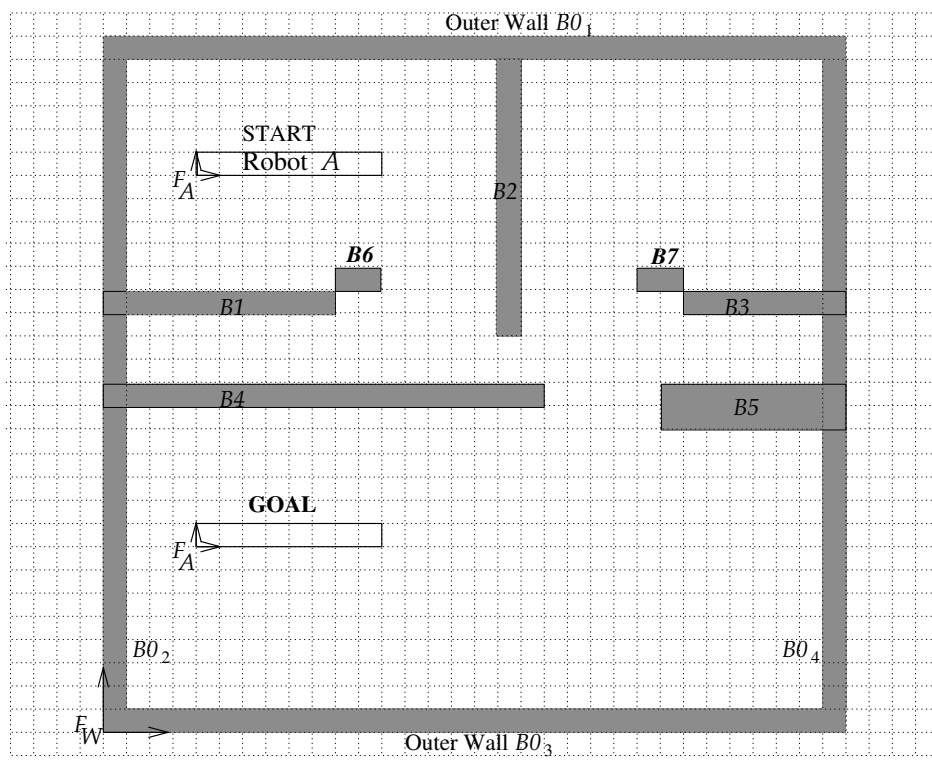
The Matlab command *axis equal* should be used when plotting the figures.

Figure 1: The Bed Movers Problem.